Date. _____

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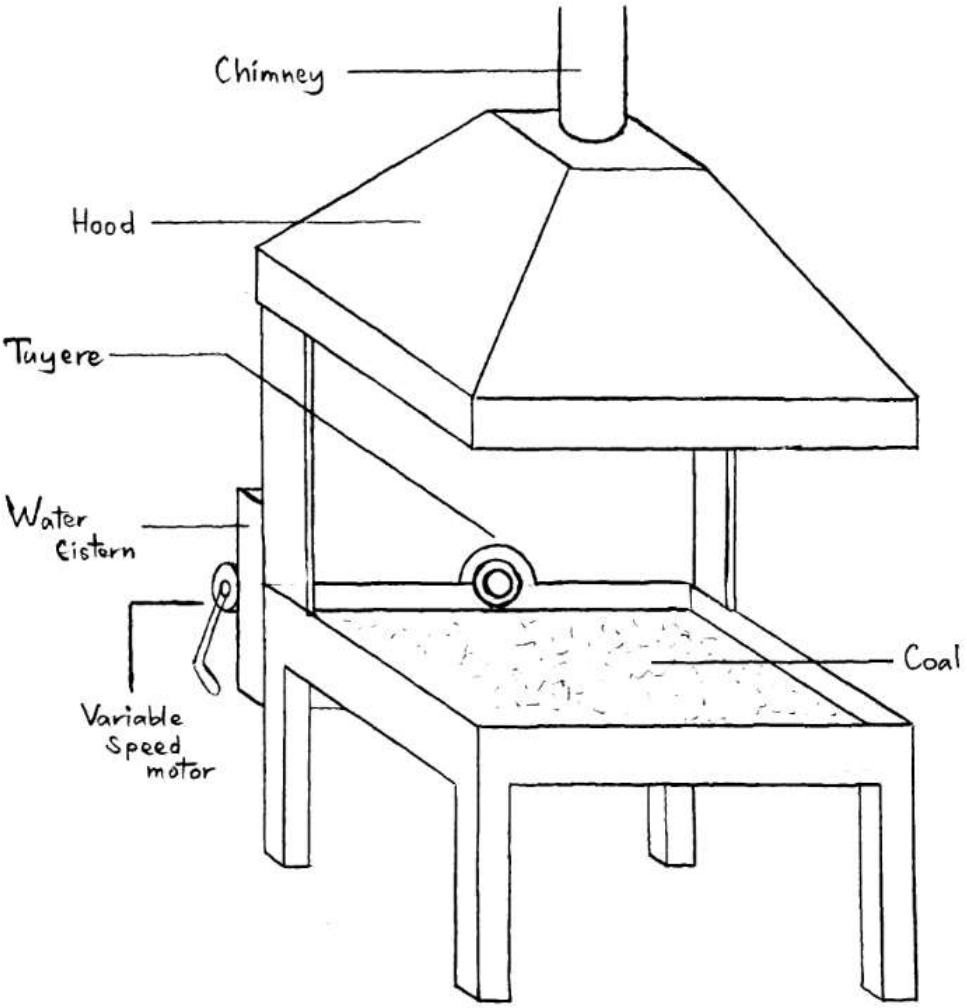
## Safety precautions :

1. Don't use loose dress in workshop, always wear shoes.
2. Don't use any damaged tools like broken handled hammer etc.
3. Be attentive in the workshop and work as per advice given by the instructor.
4. Don't talks while working and keep sincerity in the workshop.
5. Don't operate any machine until instruction is given by the instructor about it.
6. Keep all the articles in proper place.
7. Alays use your tools very carefully with your co-partners.
8. Don't stand directly in front of hammering person.
9. Keep all the tools neat and clean.

Teacher's Signature : _____




Hearth

Open fire

Date. _____

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## Introduction:

Smithy is an art of forging shapes by deforming metals or hammering or by various operations. This includes deforming metals in an open fire or hearth, hammering to get desired shapes, sometimes drilling and cutting etc. The place in which these works are carried out is known as Smithy shop.

## Hearth:

It is a type of forge used for heating metals having a robust cast iron or steel structure consisting of 4 legs support. It has a hood at the top and tuyere opening into the hearth either from the rear or from the bottom. The hearth carries the coal and is provided with firebricks to withstand the extensive heat produced due to coal combustion. In absence of these bricks the heat produced will directly effect the metal structure of the Hearth and the base and bottom along with legs and it's surrounding wall may even melt, resulting in collapse of the Hearth.

An air blower supplies pressured air through tuyere opening to the hearth to undergo combustion and control the heat, which can either be hand operated or power driven. At main pipeline a valve is incorporated in the auxiliary pipe just before the tuyere to control the air supply to the furnace. The chimney provided at the top enables as easy escape or exhaust for smoke and heat. A water tank may be additionally added for immediate quenching of hot metal.

2 methods are used to fire a Smith's forge or hearth —

[1] Open fire: Open fire, sometimes called loosefire is convenient for all general work. In openfire fresh coal is placed on previously burnt coal cyclically, in the hollow space in front of tuyere nozzle. When fresh coal is burnt and the sides also run out of them, more fresh coal is supplied from outside, also keeping the flame at a single spot and covered all the time. The coal should be slightly clamped with water and clamped down with shovel. In the desired spot for flames, the coal should be teasened with a packer to ensure uniform heating and sides should be turned time to time.

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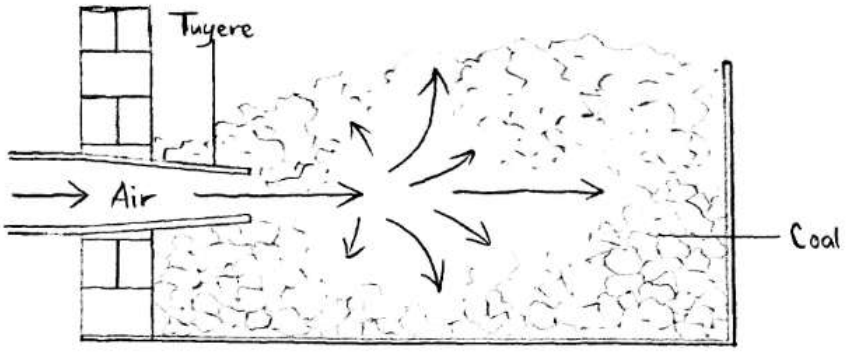
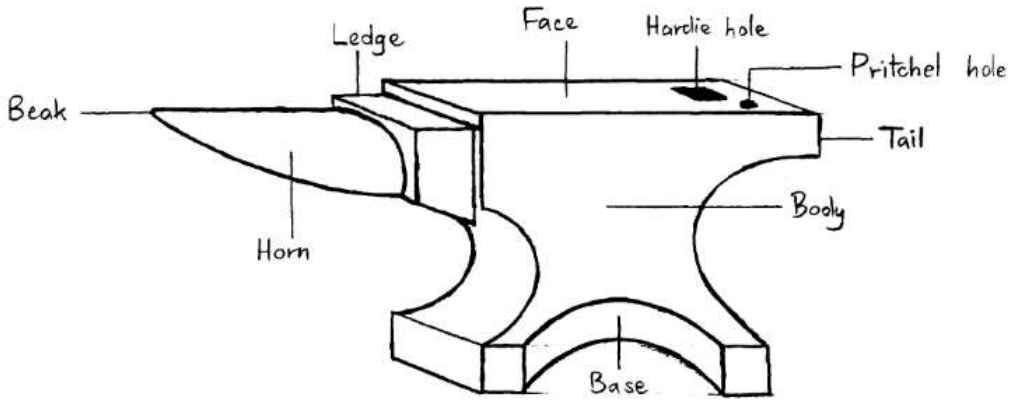
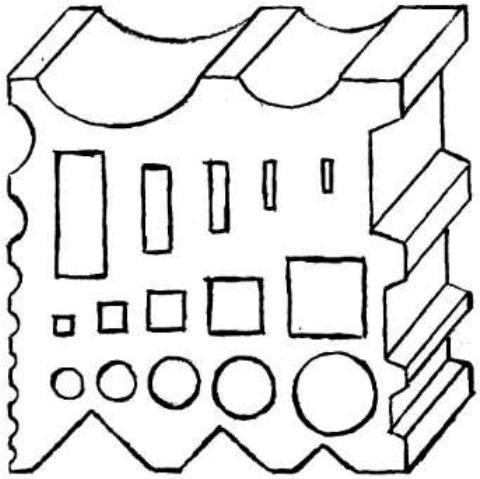



Stock fire




Anvil



Swage block

[2] Stock fire : A stock fire is extended for several hours to make it works with large pieces, where heat may have to be kept for a long time. It's another advantage is that work may be turned in all direction because of sufficient time to ensure uniform heating. Stock fire is made up packing coal around a block of desired shape placed near the tuyere nozzle, then coal upon it is clamped with water. Pulverized coal is suitable for stock fire. The block is drawn from the bed of the hearth with a turning force to prevent the stock from breaking and a tunnel is thus formed with an opening at the top. The fire is lighted in the hollow space, from the bottom of tunnel coal is removed in small amount and the cavity is formed for clinker to fall.

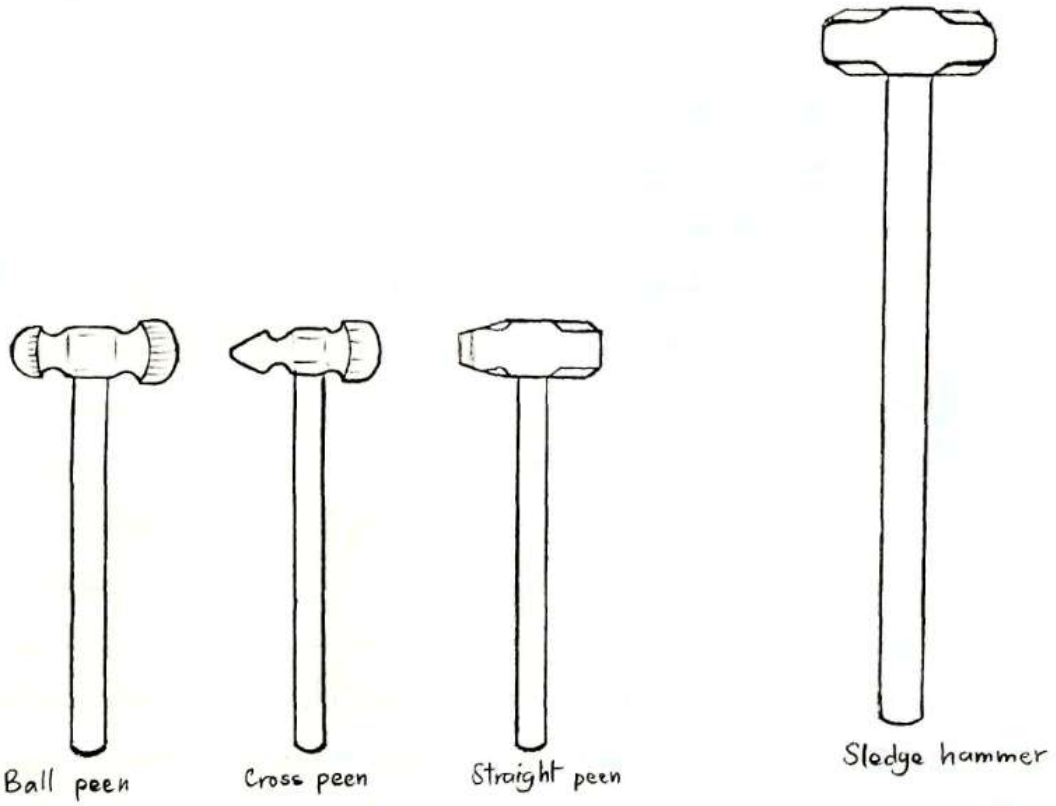
## Hand tools and Operations :

1] Anvil : The anvil is a holding or supporting tool for a blacksmith's hammering and bending. Body of the anvil can be of cast iron or tool steel but the upper part or the face is always steel, complete iron anvils are cheap and unsuitable as they deform and lack rebound when struck. On the anvil, the (round) Pritchell hole is to bend round bar, rods of small diameter; and (square) hardie hole is to hold bottom fullers, swages, bottom chisel and perform bending, punching, flattening etc. All of it's parts are — base, body, ledge, horn, beak, hard face, hardy hole, pritchell hole and tail Most of the cutting is done on ledge, bending on horn and flattening on face.

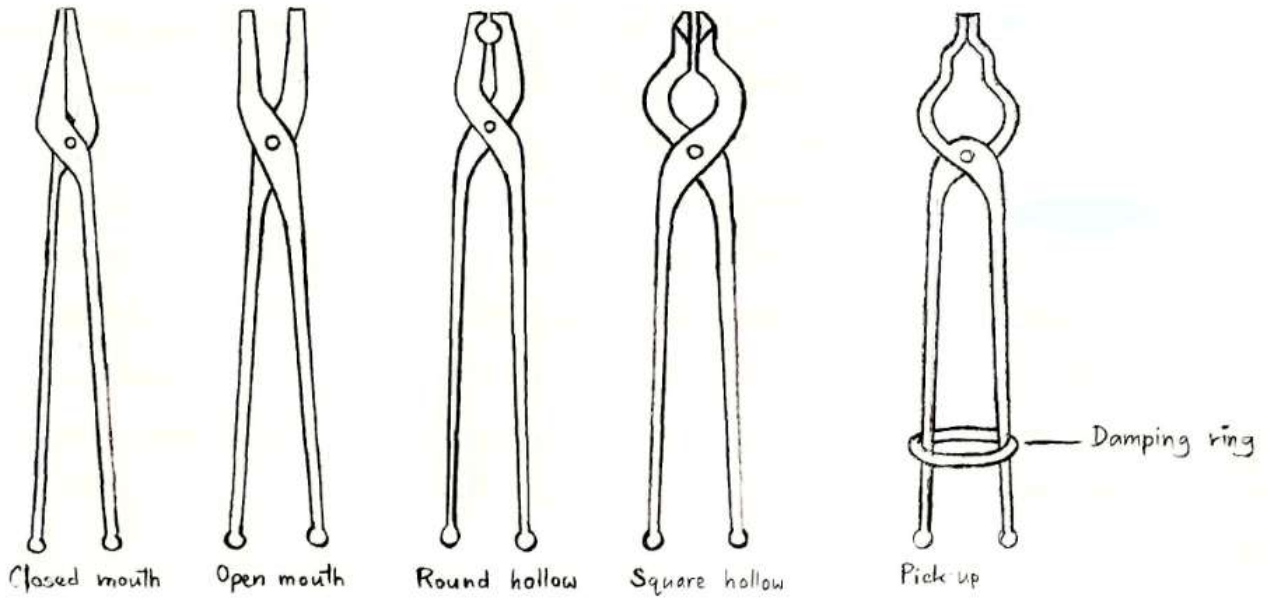
The most common anvil is 150 kg and is placed on a wooden block or separate cast iron stand to save floor from force impacts, for a distance at least 60-70 cm from floor to face.

2] Swage block : Swage block is a large, heavy block of cast iron or steel with holes and sides of squre, rectangular, circular and half groove shapes forged into them. It is used for squaring, sizing, heading, bending and various shaping, heading bolts etc, either flat or edgewise on it's stand. It is of 25 cm height and it's various sized shapes are not limited to only cutting, punching and forming. It is useful for shaping bigger sizes not suitable for anvil.

Teacher's Signature : _____




Hammers




Tongs

Date. _____

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3] Hammer: Hammers are the most common striking tool which are of 2 types —

i) Hand hammers

ii) Sledge hammer

The hand hammers used in Smith's forge are —

a) Ball Peen hammer: This is the most common hammer, sometimes called Engineer's hammer or Chipping hammer. The peen is spherical or ball in shape which is hardened and polished. This hammer is chiefly used for chipping and riveting. It's weight is about 0.11-0.99 kg.

b) Cross Peen hammer: It has a peen of blade like shape but thick not sharp. It is mainly used for bending, stretching, hammering into unreachable, restricted areas like inside curves, inside corners, shoulders etc. It varies from 0.22 kg to of 0.91 kg.

c) Straight Peen hammer: Straight Peen hammer has a peen that is straightened parallel to shaft axis. It is used for stretching or peening the metal. It varies in 0.11-0.9 kg.

Hammers are made of cast steel with tempered and hardened heads having a wooden handle. The weight varies from 0.5 - 2 kg.

Sledge hammers are used for heavyworks or by Smith's helper or striker. It varies in 4 - 10 kg with shaft of at least 1 m. having an almost cylindrical head.

4] Tongs: Tongs are required to hold or handle hot working metal, thus made of mild steel. Various types of tongs are as follows —

i) Closed mouth tong: It is used for holding thin sections of metal.

ii) Open mouth tong: It is used to hold thick metal sections.

iii) Round hollow tong: It is used to hold round or polygonal bars.

iv) Square hollow tong: It is used to hold square, hexagonal or octagonal works.

v) Pick up tong: It is used to pick up any metal from forge or hearth and not for holding while working.

In order to relieve strain for Smith during long forging operations, a damping ring is provided around the tong handle.

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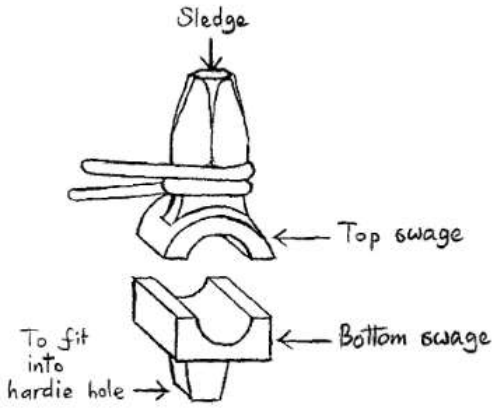
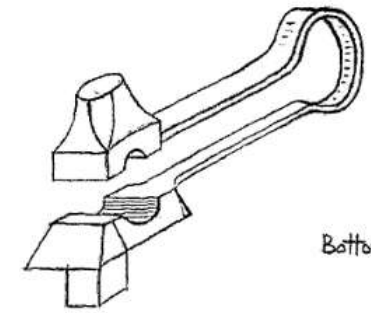
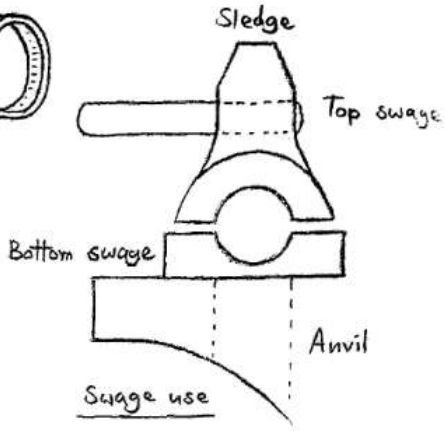
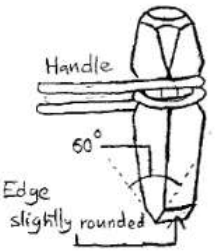


Standard swage

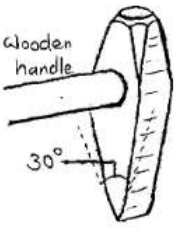

Spring swage



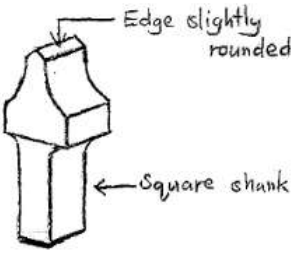
Swage use



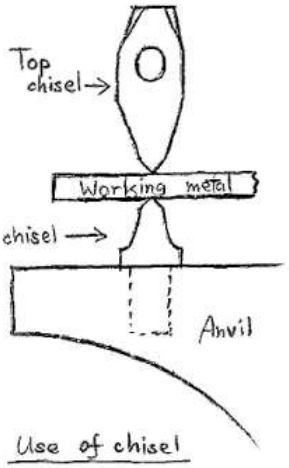
Cold chisel



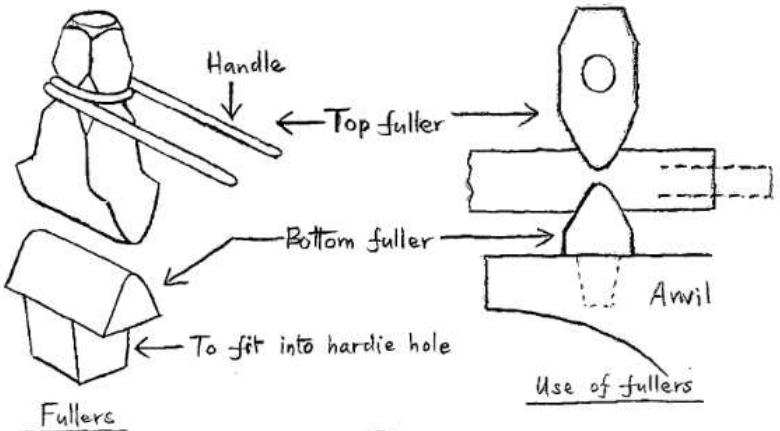
Hot chisel



Bottom chisel (Hardie)



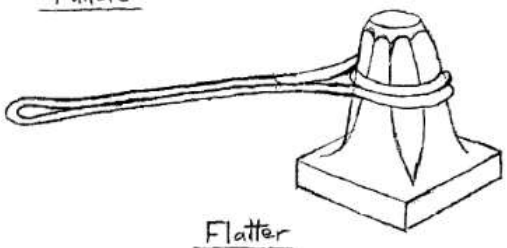
Use of chisel

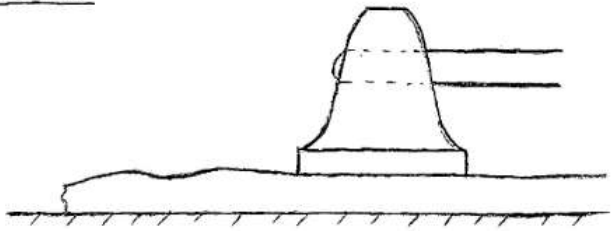


Fullers



Use of fullers


Flatter


Use of flatter

5] Swages: The swages are used to reduce and finish working metal to round or polygonal form and are made with half grooves of dimensions to suit the work. The swages may be in separate top and bottom halves and 2 holes may be connected by strip or spring tool, thus enabling the Smith to use them single handedly. Top part contains a handle and bottom part contains a square shank which fits in the hardy hole on the anvil face.

6] Chisels: The chisels are cutting tools or used for nicking prior to breaking. They may be cold or hot depending upon whether the working metal to be cut is cold or hot. The main difference between them is in the edge.

The cold chisel is made of tool steel with a cutting angle of about 60° and it's edge is hardened and tempered, with a handle made of iron rod bent around a fullered recess in the chisel body. It's angled edge should not be quite straight but slightly rounded.

The hot chisel is made of low Carbon steel and has a cutting edge angle of 30°, the hardening of edge is not necessary as the hot metal would soften it. It handle is made of a wooden shaft.

The chisels are usually used in pairs of top chisel and bottom chisel. The top chisel is held by the Smith and may be hot or cold. Bottom chisel has a square shank and held by anvil's hardie hole on anvil face.

7] Fullers: Fullers are used for necking down a workpiece, serving as a starting point for reduction of working metal before other reduction tools. It is mainly used to reduce the metal while making shoulders. These are made of tool steel and made in pairs of top and bottom. The top fuller is held by the Blacksmith, struck by the Striker and bottom fuller with a square shank is fitted into hardie hole of anvil face. The fullers are made in various sizes according to requirements.

8] Flatters: A flatter is used for finishing, flattening or smoothening the flat surfaces of already worked metals. It is made of tool steel and comes in 7.5 cm sized square or round. It is struck by a hammer on the head. It's handle is made of an iron rod bent around the head.

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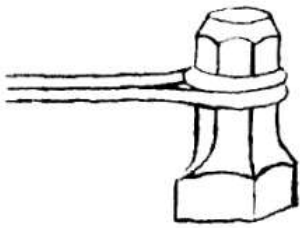
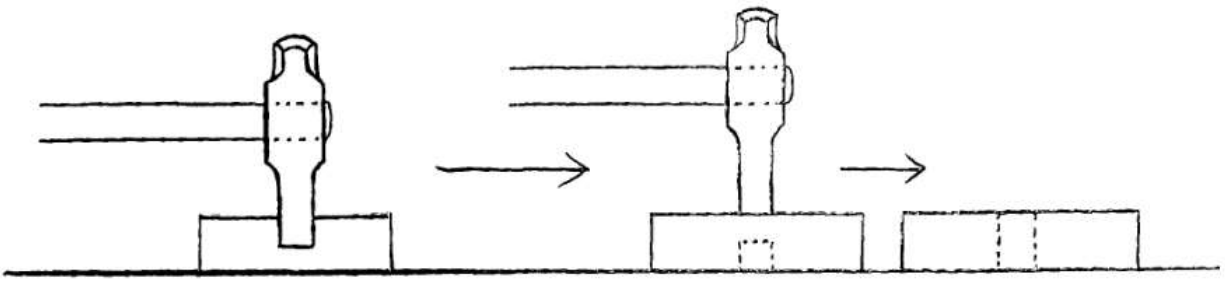


Set hammer

Round punch

Square punch



Punching a hole

9] Set hammer: Set hammer is a striking tool similar to flatter but smaller in size. It is made up of forged steel that is hardened and tempered. It is available in 4 cm square shape. It is used to set down shoulders or smooth out fuller marks near the shoulders blacksmith finishes the work with flatter.

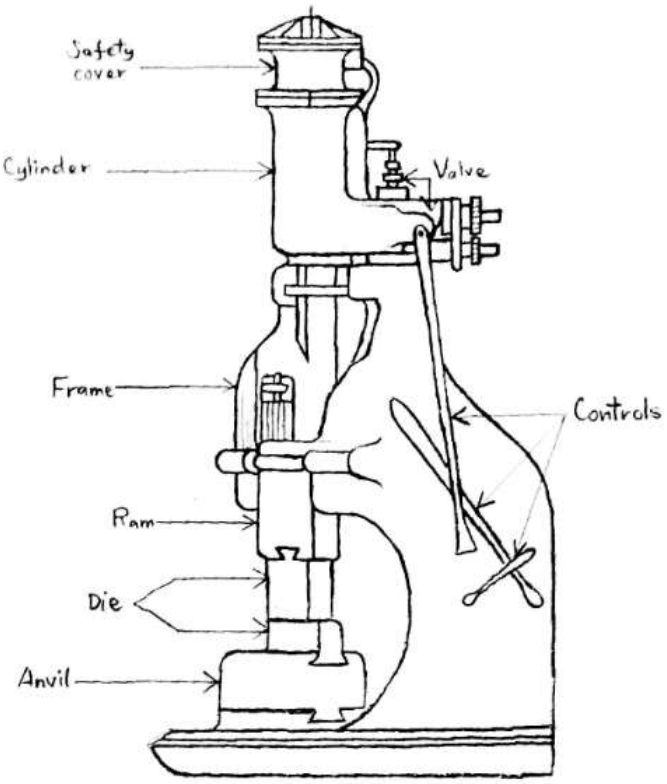
10] Punches: Punches are used for making holes in hot metal or to fix drilling points. These are made in various shapes and sizes such as square, round, oval etc, made of tool steel, hardened and tempered. It is used by placing the metal on anvil's Pritchel hole to pass without damaging the section. Generally punching of a hole is carried out from both sides to avoid defects.

- Common Forging Operations:
  - a] Upsetting (increasing cross sectional area)
  - b] Drawing down (reducing cross sectional area)
  - c] Setting down (local thinning down or finishing)
  - d] Bending
  - e] Hand welding (joining metal pieces by heating)

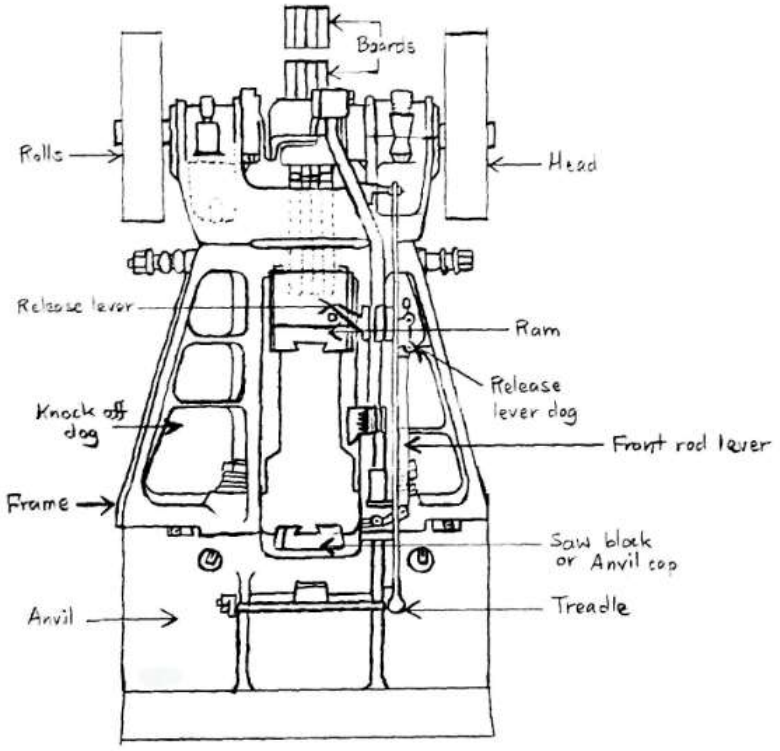
- Drop forging:

All Smith's forging above are useful and undispensable but not suitable for large number of identical forgings at industrial level. For these large quantities of sound and high quality identical structures, the method Drop Forging is used. Drop forged parts are used mostly in the world like in automobiles, Aeroplanes, railroad equipment engines, agricutural implements, household appliances etc.

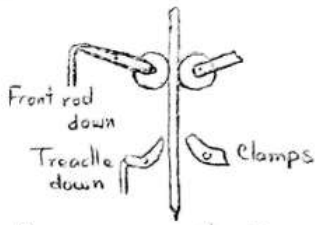
It consists of hammering heated bars or billets of steel or other metals into closed impression dies which compress the metal causing it to flow and fill in the die completely. A complete close impression die consists of 2 steel alloy blocks. One of them is top or upper die that is fastened to the ram of a steam drop hammer, board drop hammer or other type of power hammer. Another block is the bottom or lower die and it is fastened to anvil. The impressions for



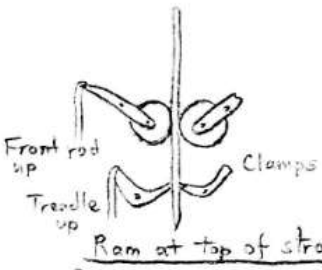

Steam drop hammer



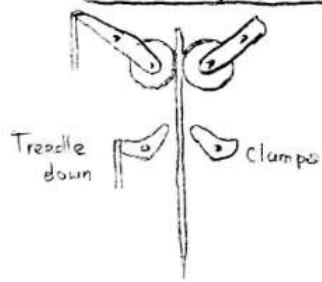

Board drop hammer




Ram goes up automatic repeat




Ram at top of stroke




Ram falling

producing the desired shape to be forged are mechanical in the working surfaces of each die half where they are formed. Since machined die impression are employed, a much larger variety of shapes can be forged with greater accuracy and details than it is possible with smith forging.

- **Steam Drop hammer:**

The steam drop hammer are similar to the steam hammers used for smith forging but with additional provision of larger and more accurate guides for the vertical movement of ram. These larger and more accurate bearing surfaces between the ram and the frame, guide to the top die so that it can meet the bottom die in close alignment. A steam drop hammer is not truely a drop hammer because steam is often admitted above the piston to increase the impact of falling ram. The steam pressure is used for raising the ram and for controlling the impact of the striking blows which can be varied from a light tap to a full show. The energy supplied by the impact of a steam hammer is given by, $\boxed{\text{Energy} = \frac{Wv}{2g}}$ [$W$ = total weight of all falling parts including upper die ram, piston rod and piston (in kg)

$v$ = Velocity at impact (in m/sec)

$g$ = Accelaration due to gravity (in m/sec$^2$)]

- **Board Drop hammer:**

A board drop hammer (a.k.a. Gravity drop hammer)'s ram is raised by a pair of steels rolls which rotate continuously. When they move together, it raises the hard wood boards fastened to the ram top, it continues to be raised until the release lever is actuated by the ram. This causes the rolls to move outward, releasing the ends and allowing the ram to fall by gravity. The distance of fall can be adjusted by changing the vertical position of the release lever, but once it is set, it'll remain constant during operation, thus it's not possible to late striking impact during operation. When operator takes his foot off to the treadle, a set of holding clamps keep the ram in it's uppermost position. The energy supply of a board drop hammer strike is — $\boxed{\text{Energy} = Wh}$ kg m [$W$ = Total weight of all falling parts

$h$ = Height of the fall]

Teacher's Signature : _____

Date. _____

Expt. No. _____ Page No. 08

- **Advantages and Disadvantages of Drop forging**

**Advantages :**

i) There is little wastage of material.

ii) The operations are relatively faster.

iii) No sand casting moulds are required.

iv) The strength of material is enhanced.

**Disadvantages :**

i) The closed impression dies normally cost more.

ii) The maintenance of the dies is expensive.

iii) The extra cost of removing the flash i.e. a thin irregular extra metal that is forced out between the parting surface of the dies.

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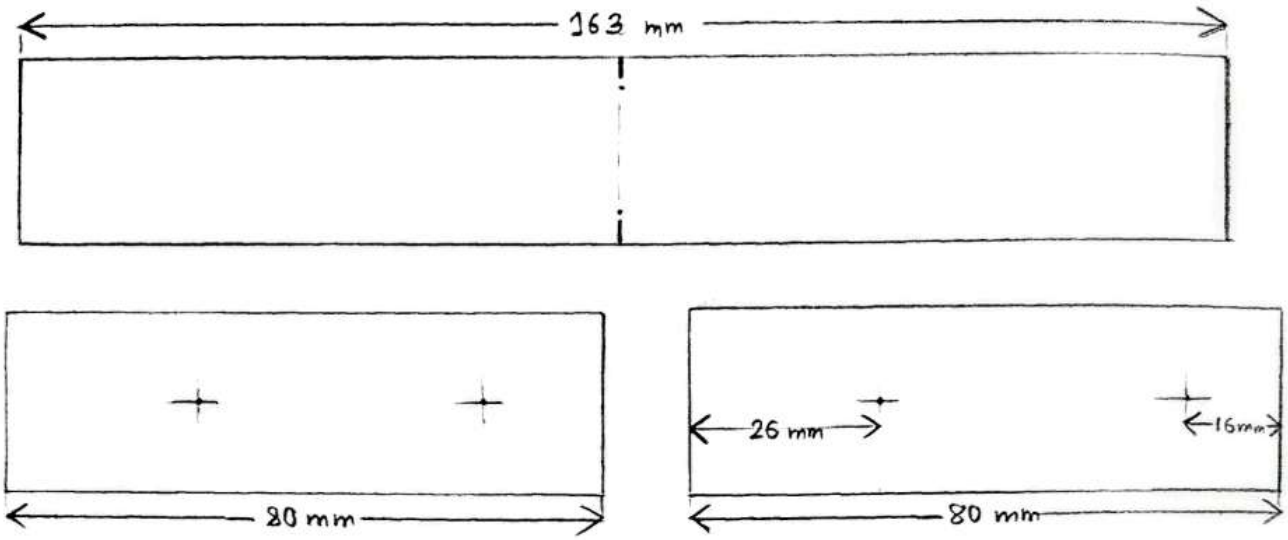
163 mm
80 mm
26 mm
16mm
80 mm

Date. 17/11/2023

Expt. No. 01 Page No. 09

**Job 1:** Double riveted single step lap joint

**Metal used:** M/S flat bar (165 x 25) mm

**Operation:**
i) Measuring and marking
ii) Cutting
iii) Punching
iv) Drilling
v) Riveting

**Tools used:**
i) Brass rule
ii) Wooden pencil
iii) Hack saw
iv) Flat file
v) Calliper
vi) Centre punch
vii) Ball peen hammer
viii) Drill machine

**Procedure:**

1) First of all, a flat piece of M/S flat bar of (165 x 25) mm dimensions is taken.
2) With brass rule and wooden pencil we mark the bar into 2 equal pieces of length 82 mm and cut it with a hacksaw.
3) The cutting surface of the bar is then filed with flat file for smoothening and finishing.
4) A distance of 16 mm and 26 mm are marked from the end of each 2 bars and are striked with ball peen hammer on center punch.
5) 2 holes are drilled on each bar at the marked point impressions.
6) 2 rivets are put keeping the bars one above another keeping the holes in line. Then the rivet tails are made rounded with help of ball peen hammer.
7) The double riveted single step lapjoint is ready to be submitted.

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